

Indirect Conversion Digital X-ray Imager using an Amorphous Selenium Photoconductor

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In large area diagnostic X-ray imaging using flat panel detectors, two detection mechanisms are dominant: direct and indirect X-ray conversion. Direct conversion detectors use thick amorphous selenium (a-Se) vertical multilayer structures coupled to an amorphous silicon (a-Si:H) thin film transistor (TFT) backplane. This type of detector is susceptible to temporal artifacts such as image lag and ghosting caused by charge trapping as well as more practical concerns associated with high voltage biasing, where 2500 V is typically used to bias a 0.25 mm thick mammography detector. Alternately, in indirect X-ray imaging, a green-emitting scintillator such as CsI:Tl is placed atop an amorphous silicon photodiode and a-Si:H TFT array. The primary challenge is integrating the photodiode and transistor processes in a production environment due to contamination concerns associated with p-doped photodiode layers.

In the past, we reported on a single-pixel detector using an optically sensitive, a-Se metal-semiconductor-metal (MSM) lateral device [1] (see Figure 1) to obviate the need for an amorphous silicon photodiode and the corresponding contaminating p-doped layer. Moreover, the smaller thickness of the optically sensitive amorphous selenium layer reduces the high voltage requirement of selenium down to a few hundred volts.

In this work, we report preliminary results from a 32×32 pixel prototype array that integrates a-Si:H TFT pixels with optically sensitive lateral a-Se MSM detectors. The array was in-house fabricated and characterized. Recent advances in improving the wavelength sensitivity, dark current, photocurrent and quantum efficiency of the a-Se optically sensitive lateral device are also presented together with system-level characterization and the first image captured by the array.

The proposed digital imager based on lateral a-Se optically sensitive devices and a-Si:H TFT pixel circuits, when coupled to a blue light emitting X-ray scintillator appears promising for large area indirect conversion X-ray imaging. The merits of such an imager are a simpler, lower cost fabrication process along with comparable sensitivity, noise, and dynamic range performance when compared with the state-of-the-art indirect conversion X-ray imagers based on a-Si:H photodiodes.

[1] K. Wang *et al.*, “Fast lateral amorphous-selenium metal–semiconductor–metal photodetector with high blue-to-ultraviolet responsivity”, *IEEE Trans. Electron Dev.*, Vol. 57, no. 8, 1952-1957 (2010).

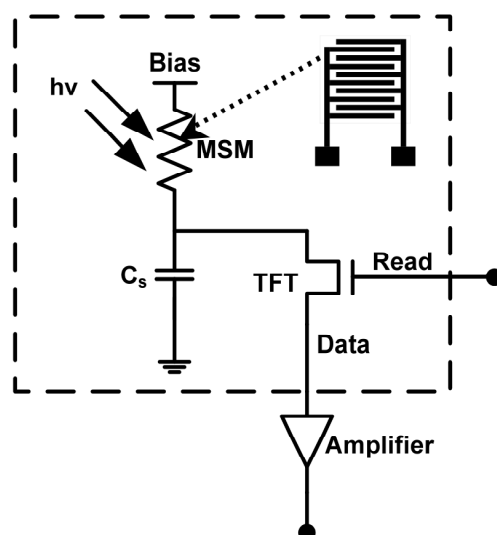


Figure 1: Pixel-level architecture: lateral a-Se MSM passive pixel sensor array for indirect conversion X-ray imaging. Insert shows one typical design of such a detector with comb-shape electrodes.